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SANDIA TECHNOLOGY

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Tech Transfer

Boosts America's Competitiveness, Strengthens National Security

ALSO:

Licensing Anti-Terrorism Technologies

Sandia-Intel Partnership, Saves Taxpayers Millions of Dollars

Sandia National Laboratories

A Department of Energy National Laboratory

Technologist Benjamin Thurston examines the debris shield that protects the focusing lends of Z-Beamlet, the third largest laser in the world. Z-Beamlet is a diagnostic tool that is used to measure whether Sandia's Z accelerator—the most powerful laboratory producer of X-rays in the world—spherically compressed a simulated fusion pellet during firing.

Sandia Technology is a quarterly journal published by Sandia National Laboratories. Sandia is a multiprogram engineering and science laboratory operated by Sandia Corporation, a Lockheed Martin company, for the Department of Energy. With main facilities in Albuquerque, New Mexico, and Livermore, California, Sandia has broad-based research and development responsibilities for nuclear weapons, arms control, energy, the environment, economic competitiveness, and other areas of importance to the needs of the nation. The Laboratories' principal mission is to support national defense policies, by ensuring that the nuclear weapon stockpile meets the highest standards of safety, reliability, security, use control, and military performance. For more information on Sandia, see our Web site at *http://www.sandia.gov.*

To request additional copies or to subscribe, contact:
Michelle Fleming
Marketing Communications Dept.
MS 0129
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185-0129
Voice: (505) 844-4902
Fax: (505) 844-1392
e-mail: meflemi@sandia.gov

Sandia Technology Staff:
Laboratory Directed Research & Development Program Manager: Chuck Meyers, Sandia National Laboratories
Editor: Chris Miller, Sandia National Laboratories
Writing: Ryan DeMares, Margaret Lovell, Technically Write
Design: Douglas Prout, Technically Write
Photography: Randy J. Montoya and Lynda Hadley, Sandia National Laboratories

FROM THE *Editor*

Dear Readers:

What do nuclear weapons, lighting in hogans on the Navajo Nation reservation, Intel supercomputers, Goodyear Tires, and the development of new, high-tech companies have in common? *Answer:* Receiving technology transfers from Sandia National Laboratories.

As you will see in this issue of *Sandia Technology,* Sandia has a solid track record of transferring technology to industry. Partnerships with industry, academia, and government agencies enhance economic development, benefit Americans in our everyday lives, and help Sandia by injecting new ideas and providing work that can validate and sometimes improve our work.

With strong support from the Department of Energy and its operating company Lockheed Martin Corporation, Sandia's efforts to develop partnerships have created about 4,000 tech-transfer and R&D ventures with industry. Most of these collaborations have been done since the end of the Cold War.

Many of these technologies are of national importance and contribute to the well-being of all Americans. They include the automobile air bag, some of the world's fastest computers, robotics for manufacturing, medical technologies to detect breast cancer and monitor blood-glucose levels, sensors to detect and warn of the presence of explosives, and a foam that can quickly decontaminate facilities of deadly biological agents.

Chris Miller
Editor

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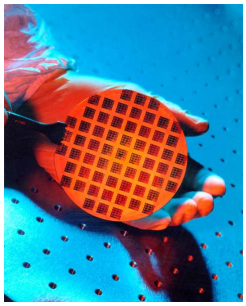


INSIGHTS

By David Goldheim

Director, Corporate Business Development & Partnerships
Sandia National Laboratories

Tech Transfer Boosts America's Competitiveness,

Strengthens National Security

The U.S. Congress in 1989 passed the National Competitiveness Technology Transfer Act, instructing the national laboratories to include technology transfer in their missions by sharing their research and development directly with the private sector. Technology transfer enhances U.S. industry's competitive position globally, reduces the Department of Energy's (DOE) costs, and brings new ideas and processes from industry to the national labs.

New Mexico's congressional delegation has been at the forefront in sponsoring legislation to stimulate technology transfer from the national laboratories.

"The importance of transferring government-sponsored technology to help U.S. industries cannot be overstated," said Senator Jeff Bingaman, D-N.M. "The economic development generated by transferring technological advances at Sandia is vital to the success of local and national businesses in the marketplace."

In February 2001, Senators Bingaman, Pete Domenici, R-N.M., and Patty Murray, D-Wash., introduced the National Laboratories Partnership Improvement Act to strengthen the DOE's role in technology transfer. If passed, the law will authorize funding to improve the ability of the national laboratories to support department missions, compel each laboratory to establish a small business advocacy and assistance program, and establish a technology transfer coordinator for oversight and policy development of DOE technology transfer activities.

Sandia's decontamination foam, licensed last year to two different companies, was one of the products used to remediate contaminated buildings in Washington, D.C.

The DOE and the National Nuclear Security Administration (NNSA) has supported the use of technology transfer as a means of bringing new technologies to the marketplace, primarily where such interactions benefit the laboratories' primary missions.

Before Congress acted in 1989 to encourage technology transfer from the labs to industry, technical publications and presentations provided the primary view into Sandia's scientific progress. Over the past decade, companies have accessed innovative technologies from Sandia for licensing and commercialization using a variety of mechanisms.

Taking a look at Sandia's Cold Spray™ research system are, left to right, Neville Whittle of the Alcoa Technical Center, Gregg Wagner of Siemens/Westinghouse Power Corp., and Jeff Smith of the Howmet Corp. Sandia researcher Mark Smith, far right, shows them metal strips deposited by the system.

With strong support from the NNSA and Lockheed Martin Corp., Sandia's management and operating parent, Sandia's efforts to increase industrial partnerships and government-industry alliances have created nearly 4,000 technology transfer and R&D ventures with industry. Many of the technologies are of national importance and contribute to the well-being of every American citizen. They include the automobile air bag, some of the world's fastest computers, robotics for manufacturing, advanced semiconductor manufacturing processes, medical applications, and advanced sensors and devices to detect and warn of the presence of explosive, chemical or biological threats.

Technology transfer mechanisms

The cooperative research and development agreement (CRADA) is perhaps the best-known mechanism for transferring technologies from the government to the private sector. Through a CRADA, Sandia and one or more partners outside the federal government (usually from industry or academia) collaborate and pool the results of a jointly conducted R&D project. In addition to benefiting the industry partner, CRADAs must support government missions.

Another type of agreement—one that exists between Sandia and an industrial, academic, or state or local government sponsor—permits the nonfederal partner to access Sandia's facilities and equipment and work with its scientists and engineers to validate or improve the partner's technologies. These projects, usually called NFE (nonfederal entity) funds-in agreements, must show clear benefit for the government, must be in a technology area that is unique to Sandia, and must be paid for by the sponsor on a full-cost recovery basis.

Sandia also promotes technology transfer by making its patents and copyrights available for licensing. Within broad guidelines that govern such things as conflict-of-interest and fairness-of-opportunity activities, Sandia is free to negotiate a variety of terms and conditions for its intellectual property licenses. Although the norm is non-exclusive licenses, under some business conditions exclusive or partially exclusive licenses may be appropriate. Sandia may receive royalties on products and services or be given equity in a company in exchange for the company's rights to develop business based on the labs' intellectual property.

In addition to the better-known mechanisms for sharing its technologies, Sandia offers special programs for small and regional businesses, entrepreneurs, other national laboratories, and universities.

Sandia also has many unique facilities that accommodate research and development, which are available for use by U.S. industry, universities, other laboratories, state and local government agencies, and the scientific community. User-facility agreements enable a company representative to perform work at the facility while Sandia provides support staff for maintenance and safety procedures.

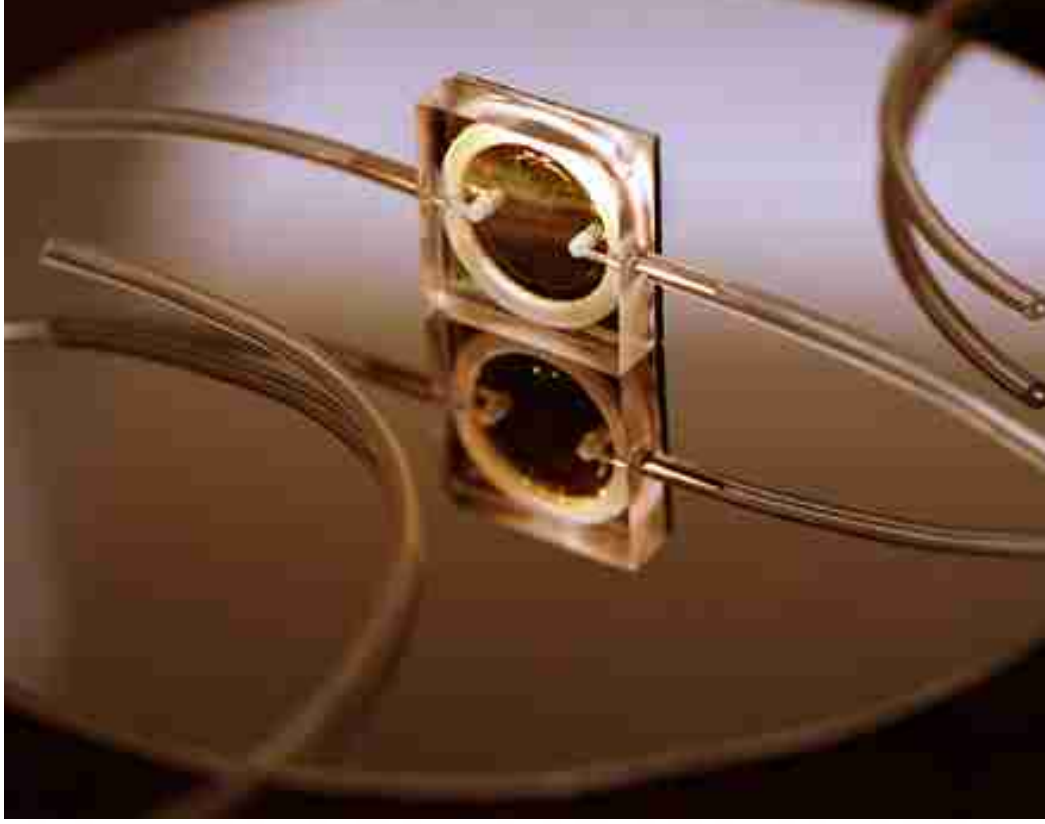
Sandia has over 25 user facilities ranging from the Combustion research Facility and the Extreme Ultraviolet Lithography Facility at Sandia's Livermore, Calif., site, to the Primary Standards Laboratory, Advanced Battery Facility, and Electronic Quality and Reliability Center at Sandia in Albuquerque, N.M. A complete description of all the user facilities can be found at *www.sandia.gov/partnerships/facilities_list.htm.*

Partnering takes many shapes

Sandia partners with both large and small businesses, universities, and government agencies to bring new technologies to the marketplace.

Among large businesses, the most successful partnerships have included work with Goodyear Tire & Rubber Co. to develop better automobile tires (see page 8), an agreement with Intel Corp. to produce radiation-hardened microchips (see page 10), and a

The affiliations permit Sandia to remain close to industry needs and to develop a regional constituency that supports Department of Energy programs and educates the region about the labs' national security mission.



A dime-sized biocavity microlaser, connected to tubes that aspirate brain cells in fluid, may aid patients by detecting cancer cells during surgery. Sandia has worked with the University of New Mexico's School of Medicine to determine its characteristics.

partnership arrangement with other national laboratories and several large businesses including AMD, Intel, Motorola, IBM, Micron, and Infineon to develop the next generation of integrated circuit lithogaphy using extreme ultraviolet technology (see page 13).

Over the past few years, Lockheed Martin Corp. and Sandia have formed a strategic partnership to apply technologies and systems developed by both organizations to the challenging defense and security threats of our changing world. The research has resulted in the development of a variety of technologies, including sensors, robotics, situation modeling, support systems and logistics with applications for both defense and nondefense customers.

At the other end of the business spectrum, Sandia is working with a growing number of small businesses. The New Mexico Small Business Assistance Program allows Sandia to provide up to $10,000 worth of consulting assistance annually to small businesses in rural New Mexico, and up to $5,000 each year to small businesses in urban areas of the state. Sandia is able to do that through a $1.8 million-a-year credit against the New Mexico gross receipts taxes paid by the labs. Sandia's assistance to small businesses helps build local companies and supports qualified suppliers that meet Sandia's mission needs.

The type of assistance has been as varied as the types of businesses. They include the refinement of a process for making highway signs from recycled materials, the elimination of airborne contaminants in a cooling system, the development of an adhesive to patch pinholes in an inflatable tube used for winemaking, and a mechanized system to pick and sort chiles to reduce the amount of debris in the harvested chile.

"Regional partnerships like these are critical for a variety of reasons," said Sandia vice president Lenny Martinez, who advocated creation of the program with Sandia vice presidents Bob Eagan and Al Romig. "Small businesses are vital to New Mexico's economy. Ninety-five percent of the state's businesses are classified as small, and they employ 46 percent of the state's workers. However, they are also more susceptible to going under when the economy turns sour."

The federal government created the national Small Business Innovative Research (SBIR) program to promote innovation and technological commercialization in support of federal agency missions. Sandia supports SBIR through the sponsorship of training workshops that help small businesses understand laboratory program requirements and proposal-writing skills to enhance their likelihood of winning federal funds.

Sandia also helps state and county economic development offices attract high-tech companies, particularly those in microelectronics, biomedicine, optics, and information technology. Sandia participates in many state and regional economic development organizations, including the New Mexico Industrial Development Executive Association, the Association of Commerce and Industry, Albuquerque Economic Development, the New Mexico Rural Development Response Council, and community economic development organizations. These affiliations permit Sandia to learn industry needs and to develop a regional constituency that supports DOE programs.

"Our aim is to increase supplier

Willie Shoemaker, National Horse Racing Hall of Fame jockey, is interviewed about a new medical device designed by American and Russian nuclear weapons scientists. The Generic Total Contact Seat™ offers hope to Shoemaker and millions of other Americans at risk for painful pressure ulcers caused by lack of mobility and poor circulation. The device was developed by Numotech, but scientists at Sandia drew on their expertise in battery technology, miniaturization, energy conservation, and other technologies used for weapons development to help Numotech create a reliable, effective, and economical device.

quality in the Four Corners area and El Paso (Texas) County," said Toni Kovarik, who works in Sandia's Small Business Advocacy Office.

The Mentor Protégé program, was launched as a pilot project in 2001. The new program provides 12-month partnerships with existing suppliers and with other small businesses that might potentially become suppliers to Sandia or other New Mexico large organizations. Sandia currently has six partners in the program.

Two options to stimulate entrepreneurship include the Entrepreneurial Consulting Program, which allows technical employees to consult with small, high-tech companies in California and New Mexico; and the New Ventures program, which facilitates the commercialization of Sandia technology by allowing technical entrepreneurs to separate from Sandia with the option of returning.

Vic Chavez, manager of Sandia's Regional and Small Business Partnering Department, said these activities offer Sandia technical staff an opportunity to see the labs' technologies at work in a variety of applications that are beneficial to small businesses and to Sandia.

Sandia established the Royalty Sharing Program to provide inventors, authors, contributors, and technical organizations throughout Sandia the opportunity to receive royalties from technology licensing. Sandia has distributed about $2 million in royalty incentives to qualifying employees since the program's inception in 1993.

Technology Ventures Corp.

Lockheed Martin Corp., which manages Sandia for the DOE, formed Technology Ventures Corp. (TVC) in 1993 to encourage technology transfer from Sandia. TVC serves as a facilitator and a broker, helping entrepreneurs develop business cases around technologies and finding investors from across the country to fund New Mexico business formations. The nonprofit corporation is an important contributor in the formation of new businesses and in the expansion of existing businesses built on leading-edge technologies developed at DOE laboratories .

Contact:

Sherman McCorkle
TVC President & CEO
505-246-2882
sherman.mccorkle@lmco.com

University partnerships

Sandia collaborates with universities to create new science and engineering programs, train the next generation of scientists and engineers, and employ complementary resources and skills to achieve common goals. These collaborations improve Sandia's ability to recruit top students for Sandia's workforce, ensuring Sandia's future as a leader in technology.

For more information on partnership opportunities with Sandia, please visit *http://www.sandia.gov/partnerships*

Contacts:

Gil Herrera (business development)
505-284-6701
herrergv@sandia.gov

John Kelly (agreements)
505-844-8993
jekelly@sandia.gov

Denise Koker (Calif. partnerships)
925-294-2936
dekoker@sandia.gov

Steve Grieco (CRADAs, NFEs, multi-lab collaborations)
505-843-4148
segriec@sandia.gov

Kevin McMahon (licensing)
505-843-4168
kamcmah@sandia.gov

Gary Jones (User Facilities)
505-844-3130
gjjones@sandia.gov

Vic Chavez (small business, regional development, entrepreneurial programs)
505-843-4190
vachave@sandia.gov

Marie Garcia (university relations)
505-844-7661
mgarci@sandia.gov

Licensing Anti-Terrorism Technologies

Sandia develops many technologies to protect lives and property. Four of these technologies—decontamination foam, gunpowder residue detection, architectural surety software, and explosives detection portal—are gaining greater importance in America's war against terrorism.

Decon Foam

Sandian Mark Tucker sprays anthrax-killing decontamination foam for Department of Energy Secretary Spencer Abraham, left, and Homeland Security Director Tom Ridge at a national laboratories' counterterrorism expo in Washington, D.C.

MODEC, Inc., of Denver, Colo., and EnviroFoam Technologies, Inc. (EFT), of Huntsville, Ala., are two Sandia partners that hold nonexclusive rights to develop the same decontamination formulation technology, also known as decon foam. MODEC specializes in mass casualty response systems for weapons of mass destruction, while EFT designs and manufactures foam-deployment systems for fire suppression and other applications for local, state, and federal agencies.

Sandia's formulation neutralizes chemical and biological agents. It can begin decontaminating a site even before a specific contaminant is identified. The formula is nontoxic, noncorrosive, and environmentally benign, yet highly effective when used as a first response against chemical-biological agents such as VX, mustard, soman, and anthrax. The decontamination formulation can be deployed as a foam, mist, fog, spray, or liquid. It was used recently to rid Capitol Hill buildings of anthrax.

The Department of Energy's Chemical and Biological National Security program funded the development of this decontamination formula.

Contacts:

Gary Jones
505-844-3130
gjjones@sandia.gov

Cecelia Williams
cvwilli@sandia.gov
505-844-5722

Gunpowder Residue Detection

Law enforcement needs a tool that quickly, accurately, and inexpensively identifies whether a person recently fired a gun. A new gunpowder residue detection technology can do that even if the shooter attempts to wash off the traces of gunpowder. This technology could also assist airport security personnel or others who need to determine if an individual has recently been in contact with gunpowder-based explosives.

Law enforcement officials can use the technology at a crime scene to save crucial investigative time. In the past, the apprehension of a shooting suspect sometimes required results from a remote forensics laboratory, thereby hampering the ability to quickly solve the crime. Sandians Pam Walker and Phil Rodacy developed the field-portable

Rudy Matalucci, a Sandia civil engineer, is closely involved in the development of RAMPART™, a software program that performs multidimensional risk analyses on buildings.

detection technique to provide police with immediate confirmation of recent gun use.

"Statistics show that the first 72 hours are crucial for investigation of a crime scene," said Walker, a project manager in Sandia's Explosive Components Facility. "When called to the scene of a shooting, officers need to rapidly isolate suspects from witnesses."

Sandia has an exclusive licensing agreement with Law Enforcement Technology (LET), Inc., of Colorado Springs, Colo., to bring the kit to market. LET is a privately held company specializing in technologies for law enforcement, corrections, private security, and military markets. Early in 2002, LET will market the field test under the name "Instant Shooter ID Kit."

Contacts:

Kevin McMahon
505-843-4168
kamcmah@sandia.gov

Pam Walker
505-845-9210
pkwalke@sandia.gov

Architectural Surety®

The Architectural Surety® program applies Sandia technologies to the behavior of homes, public buildings, and infrastructures under natural disaster or terrorist attack conditions. Sandia's surety experts developed two architectural design and construction software programs for safer buildings and dams. The programs assess such factors as how buildings respond to blast or whether a dam adequately provides electric power. Sandia is now ready to license these programs. RAMPART™ (Risk Assessment Method — Property Analysis and Ranking Tool) performs multidimensional risk analyses on buildings, and RAM-D™ (Risk Assessment Methodology for Dams) assesses hydroelectric dam vulnerabilities.

The General Services Administration intends to use RAMPART to predict the risks of terrorism, natural disasters, and crime on nearly 8,000 federal buildings nationwide. The software applies equally to the private sector, said Regina Hunter, RAMPART's technical lead.

"Traditionally, buildings have been constructed to code, which pays attention to disasters that have already happened," Hunter said.

"RAMPART looks to the future probability of events occurring and what there is to lose if those events take place. The attack on the World Trade Center shows how difficult it is to imagine scenarios for terrorist attacks," she added. "We think RAMPART's original approach—'Is this building an attractive target? What has it got to lose?'—is still the right one."

The impetus for RAM-D came from a 1998 Presidential Directive that urged federal agencies to find new, effective ways to protect U.S. information systems, facilities, and infrastructures from terrorist threats. A security assessment methodology was requested for dams to determine the state of security at specific dams, the risk of a malevolent attack at that particular dam, and the effort required to upgrade the security system to reduce risk.

Rudy Matalucci, a Sandia civil engineer closely involved in the development of RAMPART™, spearheaded the development of RAM-D™ . The dam security methodology is adapted from the processes and procedures Sandia developed to protect nuclear sites. Using Sandia's vulnerability assessment and risk-management tools for non-nuclear and non-military customers leads to rethinking facility characterization, consequence evaluation, threat and adversary definitions, risk quantification, and upgrade evaluations.

"Risk management can help designers bring high-consequence or high-probability events into the equation to make sure new structures perform in acceptable ways," Matalucci said. "International terrorist activities are just one part of the threat."

Sandia is currently seeking commercial partners to support, maintain, and distribute commercial versions of RAMPART and RAM-D.

Contacts:

Cassandra Shaw
505-284-3962
chshaw@sandia.gov

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Sandia-Goodyear Team up to Create a Better Tire

When Sandia and the Goodyear Tire & Rubber Co. teamed up in 1993, Goodyear was hoping that Sandia could apply its computer modeling and simulation capability to help the company design and manufacture better tires. Sandia technologists believed the work would allow them to test their computer tools and to sharpen their skills in materials development and analysis.

"Sandia's mission in weapon systems appeared to be completely different from a tire manufacturer's goal of enhancing its market position by shortening its product development process," said Sandian Dick Steichen. "But once we looked beyond the end products, we started to realize that the fundamental technologies are actually common to many industries."

Sandia technologists became even more interested as they realized that simulating the performance of laminated tire structures consisting of fabric, steel, and various rubber compounds was a particularly difficult challenge, and that this capability would ultimately be useful in their own programs. Sandia brought to the partnership its substantial computer power and insight while Goodyear contributed its expertise and experience in polymer science. Ultimately, the combination of capabilities produced breakthroughs that not only provided insight into tire design, but also were applicable for weapons design and manufacturing.

As Goodyear applied Sandia's computer code innovations to better optimize tire performance for new car

platforms, Sandia was able to improve its neutron generator manufacturing and to develop more accurate computer models of polymer stresses, deformations, and aging effects, which in turn helped to improve the fidelity of its weapon-system models.

Over time, the partners have pursued other common interests in areas as diverse as manufacturing, fluid dynamics, vibration, acoustics, materials, and chemical-separations technologies. Sandia is drawing technological innovations from industry and both partners have learned an important lesson: Partnerships based on mutual benefit are the most enduring.

Currently, Sandia and Goodyear are working within their sixth cooperative research and development agreement (CRADA), exploring low-energy technologies to separate hydrocarbons monomers for synthetic rubber production. If successful, the work will reduce energy consumption in petrochemical processes and advance chemical separation technologies.

And in January 2002, Sandia and Goodyear signed a new five-year "umbrella" CRADA to streamline joint research and development work.

Al Romig, Sandia vice president for Science, Technology and Partnerships, said Sandia is pursuing its focus on the automotive industry "because of the huge impact that this industry has on the national economy, and because of the volume and variety of components and suppliers involved."

"However, this is just one part of Sandia's broader business development strategy," Romig said. "What started as technology transfer is now becoming part of Sandia's strategy to effectively fulfill its national mission of ensuring the availability of reliable, low-cost weapon systems components that have been proved effective and are available from dependable sources."

Contacts:

Clint Atwood
505-844-0816
clatwoo@sandia.gov

Dick Steichen
505-845-7252
rjsteic@sandia.gov

Hal Morgan
505-844-7045
hsmorga@sandia.gov

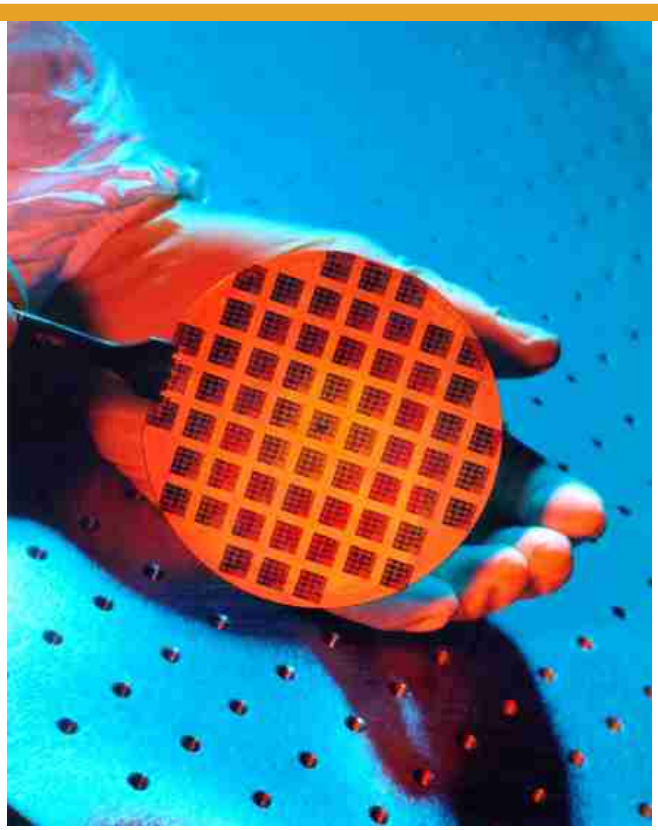
Sandia-Intel Partnership Produces
Rad-Hard Chips, Saves Taxpayers Millions of Dollars

Sandia National Laboratories and Intel Corp. have partnered on many mutually beneficial projects over the past decade. One recent project stands out for saving taxpayers hundreds of millions of dollars as well as its overall benefit to the nation: Intel's 1997 award to Sandia of a no-fee license to redesign a Pentium® processor into a radiation-hardened (rad-hard) chip for space and defense uses.

The Pentium provides a dramatic increase in the performance of rad-hard microchips, resulting in a tenfold increase in processing power over previously available rad-hard chips.

During the formal announcement, Sen. Pete Domenici, R-N.M., praised the alliance, which includes NASA, the Air Force Research Lab, and the National Reconnaissance Office. "This partnership highlights the tremendous benefits that accrue to the taxpayers, as well as to private industry when partnerships are used to leverage the resources of each party," he said.

One of the most widely used computer chips in the world, the Pentium processor was developed by Intel at an estimated cost of more than $1 billion. Its speed, flexibility, and reliability made it a valuable resource for critical government applications.



Microchips on a silicon wafer.

Radiation-hardening helps to protect chips from the harsh effects of cosmic and nuclear radiation, ensuring reliable performance.

Radiation-hardening helps to protect chips from the harsh effects of cosmic and nuclear radiation, ensuring reliable performance. The Department of Energy (DOE) has used rad-hard chips in earth satellites, space probes, missiles, nuclear weapons, and in other applications that contain electronics that could be damaged by radiation.

As the DOE's lead lab for microelectronics research and development, Sandia will fabricate and test these chips in prototype quantities in its Microelectronics Development Laboratory in Albuquerque.

Depending on the quantities of radiation-hardened chips required, either a commercial manufacturer (possibly Intel Corp.) will be licensed, or if no company is interested, Sandia will become the supplier.

Contacts:

Mary Monson
505-844-3289
mamonso@sandia.gov

Robert Blewer
(505) 844-6125
blewerr@sandia.gov

Partnering for an Expanding Mission

At first consideration, a laminar flow cleanroom may seem to have little in common with the Rolamite switch used on a nuclear warhead to detect the missile's acceleration pattern en route to a target. Yet, the defense technologies underlying these two inventions do have several significant parallels: Each of them originated at Sandia, each was commercialized by an industrial partner and found large markets in domestic products, and each is being supplied to Sandia at the lower cost made possible by large-volume production.

Originally devised in the early 1960s to bring greater reliability to weapons components, the cleanroom now is universally used in the production of microchips and semiconductors. Similarly, the accelerometer, a component of the Rolamite switch, found a widespread market in the first automobile airbags.

"We have traditionally partnered to develop suppliers for many emerging weapon technologies such as these," said Sandia technology transfer deputy director Gil Herrera. "Partnerships have helped us establish credibility in new technologies as our mission has expanded."

Sandia technologies and expertise have led to many diverse partnerships. The Specialty Metals Processing Consortium (SMPC), which is validating certain engineering simulation codes, is an example of a partnership that spans multiple business units at Sandia and helps the Labs maintain a strong technology base. SMPC is producing improved quality high-performance alloys and stable domestic supplies of specialty metals for space and defense applications.

In another CRADA, Rockwell Collins, DOE production partner Honeywell FM&T, and Sandia are sharing costs and technology to develop a new radio frequency (RF) packaging technology. In addition to the technology development, Rockwell Collins will become a second source of RF packaging technology for the nuclear weapons complex.

"The Rockwell Collins partnership will provide significant benefit to our radar systems organizations. We are anticipating up to a tenfold cost savings in RF circuit assembly production, as well as the development of a backup supplier," Herrera said.

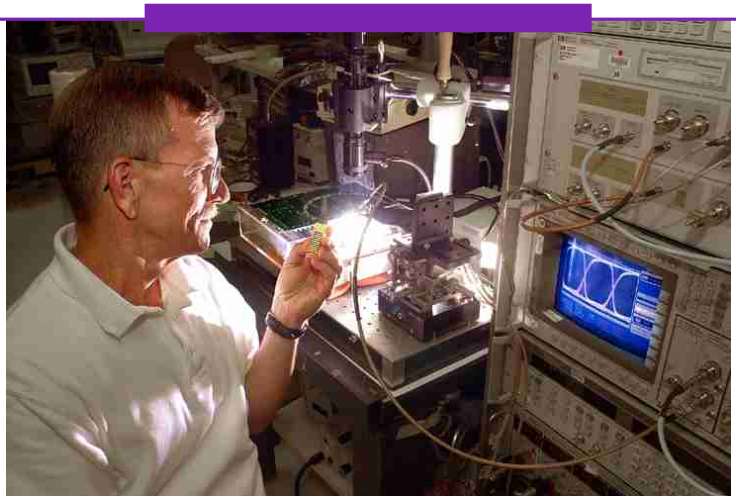
But the real value in these partnerships derives from the fact that the nuclear weapons complex does not procure components in the large volumes required to obtain sufficient data on production, cost or reliability. With constraints on budgets and restrictions on weapons testing, commercialization has become important to qualifying the reliability of defense technology as well as in providing advanced component systems for national security.

These partnerships bolster Sandia's work in nuclear weapons and related applications and have helped the labs establish its role as one of leading institutions that contributes to making certain that high-consequence systems work as intended.

Contact:

Gil Herrera
505-284-6701
herrergv@sandia.gov

Science & Technology Park Fosters Sandia Partnerships



Sandia researcher Dave Peterson inspects a high-speed optical transceiver module, which about 50 Sandians helped to develop for EMCORE Corp.

In just five years, the Sandia Science & Technology Park has grown from a concept into a full-fledged 220-acre research park with nine companies employing over 500 people. The park, being developed and managed by the nonprofit Science & Technology Park Development Corporation (STPDC) created by Technology Ventures Corporation, serves as a virtual extension of Sandia National Laboratories, providing an ideal location for companies that want to partner with the labs. Transferring laboratory technologies to the commercial world requires face-to-face interactions, and entrepreneurs located in the park can interact daily with the labs.

Retired Sandian Dan Hartley spearheaded development of the park, which is located next to Kirtland Air Force Base in Albuquerque. He and other Sandians believed the park would provide quick, easy access to some of the world's finest research institutions, including the Air Force Research Laboratory Phillips Site, Lovelace Respiratory Research Institute, and the University of New Mexico.

Albuquerque economic development officials were enthusiastic about the park, and Sandia, the Department of Energy, the City of Albuquerque, and TVC agreed to form a park partnership. TVC established STPDC as a nonprofit 501(c)(3) organization to manage all aspects of park development, from marketing to master planning. A board of directors selected from the local community governs the STPDC.

A regional market survey later confirmed that Albuquerque is seen as a prime location for such a research park for three reasons: its relationship with Sandia, the proximity of large high-tech companies, and the region's numerous smaller technology companies that can serve as a supplier base.

The park was officially established in May 1998 when the anchor tenant, EMCORE PhotoVoltaics, broke ground on a 50,000-square-foot facility. Since then, EMCORE has added a 36,000-square-foot building to house its Optical Devices Division, and a 67,000-square-foot building to house its new Fiber Optics Division.

> *"The park represents a unique opportunity for us to leverage the labs' wealth of federally funded technologies into significant private-sector economic growth that will create high-quality jobs in New Mexico."*

Other tenants located in the park or which have acquired land in the park include: Applied Technology Associates, ARS/Sandia (a limited liability corporation), BUILD New Mexico, the Sandia Laboratory Federal Credit Union, Santonio Partners, Team Specialty Products, Analytic Solutions, and Training Solutions.

"For the first time since the inception of the Sandia Science & Technology Park, there are four different projects under construction at the same time," said park Executive Director Jackie Kerby Moore. The projects consist of the construction of new or expanded facilities for Applied Technology Associates, Sandia Laboratory Federal Credit Union, Sandia's International Programs Building, and Team Specialty Products.

Sherman McCorkle is president and CEO of Technology Ventures Corporation (TVC), a Lockheed Martin Corp. nonprofit company whose mission is to help Sandia and other federal laboratories, as well as other research institutions, commercialize technologies and create new businesses.

McCorkle continues to work closely with the park's developers. "The park represents a unique opportunity for us to leverage the labs' wealth of federally funded technologies into

significant private-sector economic growth that will create high-quality jobs in New Mexico," he said.

Richard Glass, manager of the Department of Energy's Albuquerque operations office, praised the Sandia Science & Technology Park as "a fine example of how Department of Energy and Sandia assets can be used to assist New Mexico in building a diversified economy that will help attract and grow businesses for the future."

Ray Powell, New Mexico Commissioner of Public Lands, said the park demonstrates what can be accomplished when government and the private sector work together. A portion of the park will occupy land currently owned by the New Mexico State Land Office. "The money (the state) will get from leasing this land goes directly to support New Mexico's public schools. The park also ensures that new jobs and important new technologies are created right here in New Mexico," he said.

In July, Powell presented park officials with the New Mexico State Land Office's first annual Public/Private Partnership Award.

Albuquerque Public Schools also owns land in the park.

The park has been strongly endorsed by New Mexico's political leaders, including Sen. Pete Domenici, R-N.M., Sen. Jeff Bingaman, D-N.M., and Congresswoman Heather Wilson, R-N.M., who said it is helping U.S. industry to compete in the global marketplace.

Contacts:

Jackie Kerby Moore
505-845-8107
jkmoore@sstp.org

Jim Clinch
505-844-1017
jpclinch@sstp.org

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Licensing Anti-Terrorism Technologies

Regina Hunter (RAMPART™)
505-844-5837
rlhunte@sandia.gov

Rudy Matalucci (RAM-D™)
505-844-8804
rvmatal@sandia.gov

Explosives Detection Portal

The Explosives Detection Portal is a device that can rapidly screen airline passengers as they pass through it. The portal's major advantage is its demonstrated ability to rapidly detect common explosives with a high sensitivity (parts per quadrillion).

The portal is intended to help prevent airliner hijackings and bombings by identifying passengers and airport visitors and employees who have recently been working with any of a wide variety of explosive chemicals.

The new portal looks like an airport metal detector with vents and nozzles on its inside walls and ceiling.

Although the Federal Aviation Administration has identified the portal as meeting all airport requirements and specifications, certification is still pending. Meanwhile, the technology has been licensed to Barringer Instruments for commercialization. Sandia selected Barringer from more than 12 competing companies after an intense review of technical and business capabilities.

Sandia's Explosives Detection Portal.

Barringer has begun manufacturing the walk-through portal system under the name Sentinel. The Sentinel received the Award of Excellence at the International Aviation Transport Association Aviation Security conference in 2000.

Contacts:

Cassandra Shaw
505-284-3962
chshaw@sandia.gov

Kevin Linker
505-844-6999
kllinke@sandia.gov

Extreme ultraviolet lithography (EUVL) was developed to create future generations of smaller and faster mircoprocessors.

EUVL: From Star Wars Technology to Worldwide Standard

Extreme ultraviolet lithography (EUVL) has recently risen to the top of competing technologies to become the accepted technology worldwide for patterning computer microchips beginning by 2005–07. The technology now creates features as small as 50 nanometers, allowing fabrication of microprocessors one-third the size of today's technology with 10 times the speed and 100 times the memory of commercially available chips.

Extreme ultraviolet lithography has its origins in the Strategic Defense Initiative, proposed by President Reagan in 1983.

Sandian Rick Stulen had a significant role in putting together the cooperative research and development agreement (CRADA) that turned the plasma-generated EUV light technology into a computer industry tool and is bringing its product, next-generation lithography, to the world market. As a member of the Sandia California team that was developing compact sources of EUV radiation, Stulen was making yearly briefings to AT&T, which was then developing lithographic techniques using very short wavelength light and novel imaging systems.

Sandia's strengths were systems engineering and short wavelength light sources. AT&T has an imaging camera capable of producing very fine features, but lacked a compact light source, which was exactly what Sandia could offer. And so the two research projects converged.

"The technology was interesting and good science, and everything came together well," Stulen said.

Meanwhile, Bell Laboratories was doing pioneering work in EUVL, and Lawrence Berkeley National Laboratory had developed an advanced light source that was supporting research in soft X-ray science. Lawrence Livermore also had put together a small research program based on its expertise in advanced multilayer coatings for reflective optics.

In 1993, Stulen and his colleagues at AT&T formed an industrial advisory board consisting of representatives from AT&T, Intel, Sematech, and Advanced Micro Devices (AMD) to review and guide Sandia and Lawrence Livermore activities.

The agreement establishing the virtual laboratory enabled the three Department of Energy labs to collaborate on the EUVL project as a single entity with its own management.

Kevin Krenz at the chamber of the extreme ultraviolet lithography device where workers align light used to pattern circuits in this potential next-generation approach to microchip manufacturing.

"That proved to be a terrific move," recalled Stulen. "Sandia was seeking better industry coupling since neither Sandia nor AT&T would be building the chips. The board represented the end user, the chip manufacturers."

When the board requested critical milestones, Sandia, AT&T, and Lawrence Livermore responded by establishing a set of difficult challenges.

"The next year, we met all of our milestones including fabrication of a working device using EUVL. The board was amazed. It hadn't expected that kind of progress," Stulen said.

Intel, meanwhile, grew concerned about long-term lithography needs and began to seek ideas to commercialize EUVL technology. Intel, along with AMD and Motorola formed the EUV-LLC (Extreme Ultraviolet Limited Liability Company), and Sandia, Lawrence Berkeley, and Lawrence Livermore created a "one-stop shop," a Virtual National Laboratory (VNL) with its own management, whose purpose was to develop EUVL for commercial use. The EUV-LLC and the VNL established a CRADA to develop EUV technology into a prototype EUV lithography system. The virtual lab concept was successful and has since served as a model for other programs involving multiple laboratories.

The next step is to commercialize the technology worldwide.

"Our project's primary technology recipients are the companies that make the actual lithography machines," Stulen said. "Sandia's job was to resolve the technical uncertainties and to convince companies like SVG (Silicon Valley Group Inc.) and ASML (a leading high-tech company engaged in the development, production, marketing, and servicing of advanced semiconductor processing equipment which has recently purchased SVG) that they really could build the machines."

Next-generation technology is the term used to describe what exposure technology will be used for lithography once visible light is no longer useful.

Today, the EUV-LLC has grown and globalized. In addition to the founding members (Intel, AMD, and Motorola), it also includes IBM, Micron, and Infineon. A remarkable milestone was achieved in April 2001. The Virtual National Laboratory unveiled a prototype alpha EUVL machine only four years after the program's initiation. Some 250 members of industry, government, and the three national laboratories celebrated the milestone at Sandia's California laboratory. The virtual laboratory also has produced mask blank production at Lawrence Livermore, and EUV metrology at Lawrence Berkeley National Laboratory.

Contacts:

Denise Koker (Calif.partnerships)
925-294-2936
dekoker@sandia.gov

Rick Stulen
(925) 294-2070
rhstule@sandia.gov

Sandia researchers, from left, Paul McWhorter, Sam Miller, Jeff Sniegowski, and Steve Rogers, have formed a private spinoff company, MEMX, Inc., to commercialize Sandia-developed microsystems technology.

Spinning Off New Ideas for COMMERCIALIZATION

Sandia often works with small, entrepreneurial companies to develop visionary, edge-of-the-envelope technologies. The commercialization of these revolutionary technologies often involves small groups of dedicated scientific, technical, and business people to lead the technology to the marketplace. Some of these entrepreneurial groups are homegrown. An internal Sandia program, New Ventures, facilitates the commercialization of Sandia technologies by allowing entrepreneurs to separate from Sandia with the option of returning within two years. This program fosters entrepreneurial interest by reducing personal risk.

"Commercialization of any emerging disruptive technology is a challenge that is best left to small and entrepreneurial companies," said Al Romig, Sandia vice president for Science, Technology and Partnerships. "Big companies need to manufacture products in huge quantities, and they require a huge customer base. A small company can take a DOE-funded technology, develop it into real products, market those products, and then close the loop with Sandia by making the technology available for next-generation weapon systems."

Sandians Launch Companies with MEMS and FLIGHT

In 1999, after evaluating various business options, Sandia licensed elements of its MicroElectro-Mechanical Systems (MEMS) technology and FLIGHT 3-D human-computer interface and visualization environment to Sandia entrepreneurs for commercialization. MEMX, Inc., a private company spun off from Sandia, licensed Sandia's surface mircomachine technology, an advanced five-level polysilicon surface mirco-maching process that produces more reliable and complex MEMS devices; and Novint Technologies, a computer software company, has the license for FLIGHT. Former Sandian Paul McWhorter formed MEMX in Albuquerque, and former Sandian Tom Anderson established Novint, also in Albuquerque, to take Sandia's advanced technologies from the R&D stage to commercialization.

The MEMS technology offers a novel way to put capable components—components able to sense, communicate, think, and act on their own—onto a silicon chip. "Our MEMX team spent 10 years at Sandia developing and perfecting the SUMMiT V technology," McWhorter said. "During that time, Sandia invested over $100 million in bringing the technology to a very high state of maturity."

McWhorter said the technology can be used immediately in tele-communications, with an initial focus on the production of optical switches that use Sandia's surface micromachine technology, SUMMiT V. The beauty of this process is its application of

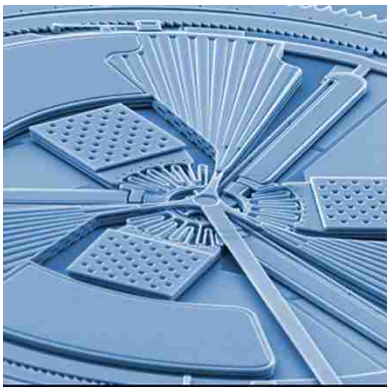
> *"Our most recent chips have over 10 million mechanical entities. It is this complexity that allows MEMX to achieve incredible performance parameters,"*

conventional silicon chip fabrication processes. All MEMS devices are batch-fabricated and when the wafer comes out of fabrication it is covered with thousands or even tens of thousands of MEMS devices, all fully assembled and operable. SUMMiT V meets industrial demand for high-performance optical switches, the driving force in the current MEMS market.

"Our most recent chips have over 10 million mechanical entities. It is this complexity that allows MEMX to achieve incredible performance parameters," McWhorter said. "I am convinced that MEMX will have a positive impact on Sandia's long-term vision for this technology."

Novint's corporate mission is to revolutionize the way people interact with computers by using haptics (the sense of touch) and other human senses in a real-time domain. FLIGHT allows users to work in a virtual world the same way they work in the real world—naturally and in three dimensions. This new interaction mode is expected to substantially increase the value of computers by saving the users time, reducing training, minimizing frustration, and improving ergonomics, all through an extremely intuitive interface.

FLIGHT is beginning to find applications in the medical world. Harvard University Hospital is using it to train dentists, and Columbia University Hospital is evaluating it to train nurses in IV insertion and surgeons in dry-running complex and delicate operations.



Sandia-developed micromachines. The bottom image shows a dust mite on top of the micromachine.

Haptics promises big improvements for software developers in many fields, including CAD/CAM, computer animation, scientific visualization, and medical simulation and training. Those fields currently are facing productivity bottlenecks because of the limitations of the existing interfaces to many areas of 3-D computing.

Novint investor Marvin Maslow said the technology will have a big influence on the Internet. "Our software allows people to interact with complex three-dimensional worlds in ways that are impossible with a two-dimensional mouse-based interface," he said.

Benefits for Sandia and the Region

Sandia benefits from having private firms test, perfect, and commercialize mission-critical technologies that are then made available to Sandia's programs. The labs can also benefit by sometimes trading part of their licensing royalties for an ownership position in the new company.

"For some technologies, there are strategic implications for the labs," said Sandia licensing manager Kevin McMahon. "In those situations, Sandia wants to maintain an on-going business relationship that supports the further development and commercialization of the technology. Equity-based partnerships allow the labs to reduce the financial obligations of startup companies while benefiting from the successes of companies built upon Sandia technologies."

Sandia has accepted equity positions with eight of its licensees, some of which are Sandia spin-offs.

Most companies that spin off from Sandia stay in the Albuquerque area to maximize interactions with laboratory staff. While this enhances the region economically, it also promotes the area as a locus of high-tech industry. The New Mexico Technology Corridor—which includes the Sandia Science & Technology Park, Sandia and Los Alamos national laboratories, the Air Force Research Laboratory Phillips Site, the Lovelace Respiratory Research Institute, the University of New Mexico, and New Mexico State University—is attracting Fortune 500 companies to partner with startup companies to leverage their technologies, talent, and resources. Some regional forecasters predict that the Rio Grande Valley from Las Cruces to Los Alamos might become the next Silicon Valley.

Contacts:

Kevin McMahon
505-843-4168
kamcma@sandia.gov

Mary Monson
505-844-3289
mamonso@sandia.gov

Making Decisions for Seven Generations

Native Americans bring traditional perspectives to technological solutions

Sandian Sandra Begay-Campbell, who is a member of the Navajo Nation and whose many relatives spent most of their lives on arid desert tribal lands near Gallup, N.M., seizes every opportunity to acquaint Sandians and representatives of U.S. government agencies with the remote tribal reservations.

"You can try to describe rural conditions, but what you say doesn't mean much until people see the poor economy and minimal infrastructures for themselves. That opens their eyes," she said.

Sandia is working with the Department of Energy and the Navajo Nation to deploy renewable energy technologies to Navajo homes in New Mexico, Arizona, and Utah. The project stems from a memorandum of understanding (MOU) that Sandia signed with the Navajo Nation in November 2000.

The cost of connecting to the electrical power grid is about $25,000 per mile, a prohibitive price for most residents of the Navajo Nation whose tribes are broadly dispersed. Solar power and windmills usually are better options, and Sandia has developed advanced technologies for all of these renewable-energy sources. The shared vision of Sandia and the Navajo Nation is that the MOU will serve as a catalyst to solve existing problems to improve living conditions.

Sandra Begay-Campbell, left, and two Navajo electrical technicians, Vircynthia Charlie, center, and Melissa Parrish check the batteries on a Navajo Tribal Utility Authority photovoltaic system in the Kayenta District, Arizona.

Begay-Campbell draws from her cultural heritage to explain options to her people and other Native Americans and to serve as a cultural interpreter to Sandia. The goal is not to push a particular technology on the Navajo Nation, but rather to listen to needs and offer choices, she said.

"It can be difficult for a technical person to understand that despite the presence of all the physical conditions that allow a particular technology to succeed, it still may not be acceptable because the community doesn't want it," Begay-Campbell said.

"Photovoltaics is a good option because it is a clean, quiet source of renewable energy that is in harmony with the Native American philosophy of Seven Generations," Begay-Campbell said. "That philosophy is to care for the earth and the people on it, care about future generations, and live as sovereign people for seven generations to come."

Part of the MOU's goal is systems integration. Sandia helps to achieve that by drawing on its expertise in telecommunications, satellite and wireless communications, and telemedicine. In a recent community forum on solar energy and photovoltaics co-sponsored by the Navajo Tribal Utility Authority, Sandia technologists discussed the concept of energy conservation and specific applications. They also explained the benefits of compact fluorescent light bulbs for households on a limited energy budget and listened to tribal concerns.

The foundation for the MOU was put in place in 1998 when former Energy Secretary Bill Richardson issued a directive to all national laboratories to create partnerships with Native American tribes and pueblos. In addition to linking the global revolution of science and technology with the oldest cultures in the United States, the MOU gives Sandia technologists the opportunity to see theory put into application. The partnership encompasses other areas of potential collaboration and cooperation, including cooperative strategies for promoting regional economic development and quality education, access to the broad range of services offered by Sandia's Corporate Business Development & Partnerships Office, and hiring more Native Americans at Sandia.

Technical Contact:

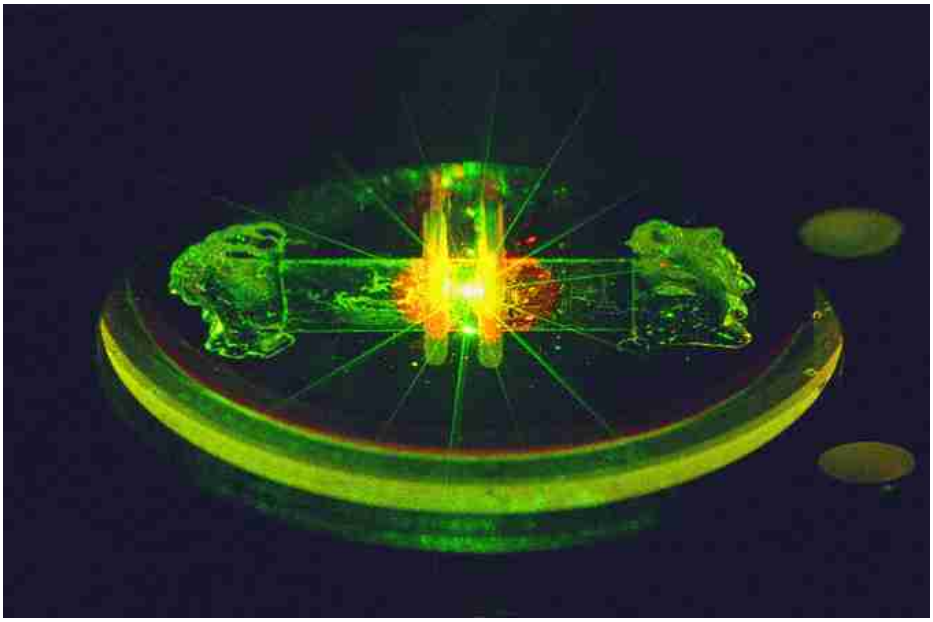
Sandra Begay-Campbell
505-844-5418
skbegay@sandia.gov

VCSEL Technology Leads to Successful Spin-off Company

More than 100 Sandians have taken entrepreneurial separation to spin off close to 40 companies from their work at Sandia. One of the Sandians, Tom Brennan, left the labs in 1995 to become co-founder of MODE (Micro Optical Devices). MODE is an Albuquerque-based manufacturer of compound semiconductors based on a proprietary Sandia technology, the vertical-cavity surface-emitting laser (VCSEL). Sandian Paul Gourley, along with many other Sandians, worked on the development of advanced manufacturing technology to produce VCSELs.

Brennan learned about VCSEL technology in the early 1980s while employed at AT&T/Bell Laboratories, which then managed Sandia. He quickly recognized VCSEL's potential in the fiber-optics connections of the future, but saw others inside and outside of the labs try unsuccessfully to bring VCSELs to market.

"For years, VCSEL was an idea ahead of its time," Brennan said. "It was only when manufacturing processes capable of reproducing the microscopic lasers were developed that VCSELs became economical from a product standpoint. At that point, a light



VCSEL: A Solid-State Laser

A VCSEL is a solid-state laser in which two mirrors and the intervening gain region are grown by depositing atoms on a substrate a single layer at a time. As light generated in the gain region bounces vertically between the mirrors, some light leaks through the surface mirror creating an emitted beam.

By contrast, the conventional semiconductor lasers that are now used in high-speed communications have two mirrors formed by cleaving the structure to expose reflective crystal facets. Light generated in the gain medium bounces horizontally between the facet mirrors, leaking out through one of the mirrors at the edge, giving the technology the name "edge-emitting laser." Edge-emitting lasers have some disadvantages, such as being difficult to test and relatively expensive to manufacture. VCSELs offer not only lower manufacturing costs but also lower packaging, alignment, and testing costs than edge-emitting lasers, as well as less power dissipation and higher reliability.

EMCORE Corp., located in the Sandia Science and Technology Park, designs, develops, and manufactures high speed vertical-cavity surface-emitting laser (VCSEL) and PIN photodiode components and subassemblies for the rapidly growing data-communications and telecommunications markets.

went on in my mind about founding a startup company."

Brennan decided to try his hand at commercializing VSCEL technology in 1995, when he began a two-year entrepreneurial separation from Sandia. He obtained an exclusive license to commercialize the technology, and then in partnership with former Sandian Rob Bryan, he co-founded MODE with seed financing from ARCH Venture Partners in Chicago, which had as a limited partner the New Mexico Investment Council.

Sandia contributed to the success of MODE in several ways: The new company's prototype devices were built at Sandia, and MODE conducted other development activities at several Sandia user facilities.

Also helping the company to succeed was Brennan's close relationship with a colleague who had left Bell Laboratories to found EMCORE, which designs and manufactures compound semiconductor products. As the only domestic supplier of a reactor used by Sandia, EMCORE preserves for the United States the ability to domestically manufacture important defense-related parts. Sandia purchased an EMCORE reactor in 1992 to use in the Labs' VCSEL research, which at that time was Brennan's project focus as a Sandia employee.

> *"A lot of people try to go into business with an abbreviated technology base. But it takes many years to acquire insight and understanding of the nuances and limitations of a technology and its underlying principles."*

The next year, EMCORE and Sandia signed a cooperative research and development agreement for reactor modeling and control. That reactor technology played an important role not only in the maturation of the technology needed by Sandia for its national security mission, but also in EMCORE's commercial success. It was in September 1997, during one of EMCORE's yearly visits to Sandia, that a company representative learned that MODE needed additional funds to commercialize its technology.

A merger of the two companies made sense to all parties. MODE would gain the financing it was seeking, and EMCORE would diversify its product line with a technology that had a large potential market. About a month after discussions began, EMCORE offered $34 million in stock for MODE. MODE accepted, marking an important milestone for the new company. MODE's management team had successfully brought a small manufacturing facility through its early stages, and VCSELs were already on the manufacturing line. In less than two years, a startup venture had grown into an organization with 200 people and nearly $30 million in sales annually of a product available nowhere else.

With the merger, Brennan left MODE to found a new EMCORE division, EMCORE Photovoltaics, and located it in Sandia's Science & Technology Park.

By 2001, more than 50 companies worldwide were manufacturing products using MODE's VCSEL technology. It had become accepted as a key component in current and future telecommunications systems. Brennan's process of commercializing the VCSEL technology has become a model for technology transfer. (A case study, *Technology Transfer from Sandia*, is published as Sand Report 2001-0642, and is available on the Web at *infoserve.sandia.gov/sand_doc/2001/010642.pdf*.)

Contacts:

Kevin McMahon
505-843-4168
kamcma@sandia.gov

Mary Monson
505-844-3289
mamonso@sandia.gov

Sandia/University Research Alliances *Address Diverse Problems*

Sandia's university research program focuses on research, talent creation, and strategic collaboration. The partnerships among Sandia and the nation's leading schools enhance the U.S. science and technology base in about a dozen primary academic concentrations, train the next generation of scientists and engineers, improve Sandia's ability to recruit top students, and ensure Sandia's future as a leader in technology.

The following two research projects in the diverse areas of medical technology and agriculture demonstrate the synergy of these collaborations.

Sandia researcher Paul Gourley examines the photomask used to microfabricate the biocavity laser flow device.

Microcavity Laser is a "Smart Scalpel"

The biological microcavity laser is a patented Sandia technology that can detect blood protein abnormalities such as cancer or sickle cell anemia. Researchers with Sandia's university partner on the project, the neurosurgery department at the University of New Mexico's School of Medicine, are helping to determine the characteristics of the biocavity laser.

Paul Gourley, leader of the Sandia team, said the microcavity laser "can quickly identify a cell population that has abnormal protein content, as do tumor cells, by passing only a few hundred cells—about a billionth of a liter—through our microsensor."

When included in a scalpel, the laser can help surgeons identify malignant tissue without sending biopsies to the pathology lab for analysis. An aspirator in the scalpel vacuums material from the incision to the microcavity laser enclosed in the handle of the scalpel. The laser produces analytical results quicker than stained cells on microscopic slides, currently the standard instrument for detecting the presence of cancer in biopsied cells. With its fast and accurate analysis, the device can tell the surgeon when to stop cutting.

Hot Stuff for Sandia's Sensors

In another university-linked research project, Sandia's Intelligent Systems and Robotics Center, the New Mexico Small Business Assistance Program, and agricultural scientists from New Mexico State University (NMSU) will help the New Mexico Chile Pepper Task Force improve the way chiles are harvested, thereby giving an important regional industry a needed boost.

Currently, a worker can selectively pick chile pods, but the process is slow. Mechanical harvesting is quicker, but it sometimes can pull branches off the plants and occasionally the process uproots entire plants that mix with the chiles. The project focuses on automating equipment to sort the peppers from the plant debris. Sandia is modifying its sensor technology to help make the mechanized picking and sorting both more effective and more economical.

"The technological challenges are great, but there do appear to be potential options to pursue technologies that could substantially improve their processes, providing that the associated integration costs are not unrealistic," said Jon Salton, Sandia's principal investigator for the project.

James Libbin, a farm management specialist at NMSU, said the domestic chile market is hurt by countries that pay low wages. Hand labor in the United States accounts for more than half the cost of chile production. New Mexico producers cultivate about 19,000 acres of chiles and the state's entire chile-processing industry has reached $200 million. The industry finds it must shift to machine harvesting to remain viable.

Contacts:

Mary Monson (technology)
505-844-3289
mamonso@sandia.gov

Marie Garcia (University Programs)
mgarci@sandia.gov
505-844-7661

INSIGHTS

By David Goldheim

Director, Corporate Business Development & Partnerships
Sandia National Laboratories

Tech Transfer (a.k.a. Partnerships) is a fundamental element of Sandia's corporate strategy. Business relationships with industry provide the conduit through which our technologies may be matured, developed into products, tested for performance and reliability, and provided to our programs as well as to our federal government customers.

Not only are partnerships with industry valuable as a means of obtaining qualified components and subsystems for our own programs, but our work with agencies other than the Department of Energy (DOE) also requires a commercial source of components and subsystems. Thus, our other federal agency (OFA) customers demand partnerships with industry as well. Such objectives form the fabric of our strategies for transferring technologies through cooperative research and development agreements (CRADA), work for others (WFO), and licensing agreements.

The examples cited in this issue of *Sandia Technology* illustrate the benefits that derive from partnerships. Through these, our partners acquire our valuable technologies and Sandia [and the National Nuclear Security Administration (NNSA)] import best engineering and business practices, acquire test data from products fabricated in large quantities, and reduce costs to our customers through leveraging our investments with those of our partners. Similarly, partnering with universities adds to our technology base and provides an alternate path for technology dissemination. And last, but far from least, such collaborations increase job satisfaction. It is extremely rewarding to solve a difficult industrial problem or embed our technologies in a product that may improve the quality of life and the economic competitiveness of U.S. industry.

We live and raise our families in New Mexico and California. Partnering with industry gives us an opportunity to impact our communities, through technical assistance to existing small businesses and by creating high-technology spin-off companies. Our support to local businesses can make *the* difference by enabling them to build an economic base, create jobs and become qualified suppliers to our programs. Their successes pay dividends by providing jobs and taxes, which improve the infrastructure, the educational system and our quality of life. Five local and regional small business programs are an integral part of our partnerships program.

Finally, our partnerships program provides career options and professional recognition. The inventive among us can continue working at Sandia while realizing royalty income; the adventurous among us may take entrepreneurial separation to transfer technology by joining a small company or starting a new company and the socially conscious can apply their intellect and creativity in support of local businesses.

Our partnerships program is robust and continues to evolve—it is a work in progress. The program has matured significantly since its revolutionary creation by the Congress and implementation by Sandia in the early '90s. We have become more business-like, more professional, more experienced and more astute in our partnering practices. And, I believe, we are providing greater value to our stakeholders—the Congress, the NNSA, the DOE, Other Federal Agency customers, our employees, our industry partners and our Laboratory.

But to be successful, it is important to remember that partnering is a body contact sport armchair quarterbacks will not succeed!

Contact:

David L. Goldheim
505-845-7730
dlgoldh@sandia.gov

"It is extremely rewarding to solve a difficult industrial problem or embed our technologies in a product that may improve the quality of life and the economic competitiveness of U.S. industry."

David Goldheim
Director, Corporate Business Development & Partnerships
Sandia National Laboratories

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